The Itty Bitty Telescope (IBT): Tips for building and using a simple radio telescope

FAST Facts about the IBT:

1. This is a 12,000 MHz radio telescope.
2. It can detect frequencies in the range of 12,200 to 12,700 MHz.
3. It is not a radio telescope system that can be used for serious sky surveys.
4. It can detect the sun.
5. It can detect blackbody radiation such as 300 deg K trees, buildings, people, when viewed against blank sky.
6. You must use it outside, or through a large window.

Parts list and options for the IBT:

1. Need the works? By an RV kit from Gorgeous Collectibles and Satellite:
   a. http://stores.ebay.com/Gorgeous-Collectibles-and-Satellite
   b. Power supply: cheaper signal meters require a power supply. You'll need 2 9-V batteries, and two battery clips or a two-battery snap (part number 123-BS-M-4A-GR) from www.mouser.com
   c. SMALL wire nuts, electrical tape
   d. Tools: wire stripper, wrenches.

2. Have a dish and a tripod? You need:
   a. Signal meter.
   b. Power supply. The Channel Master 1004IF and cheaper signal meters require a power supply. You'll need: battery clip for 8 AA batteries, 9 V battery snap and a short length of coax cable with f-connectors and items c-d above. Signal meters can be found here: http://www.a1components.com/searchn.aspx?Search=Satellite+Siganl+Meter
   and here: http://www.satpro.tv/meters.html

Putting together the dish:

Remove the dish and its parts from the box and find the LNB arm mounting screws. Align the arm and attach with the screws making sure to keep the button screws flush with the surface of the dish as shown below.



Step 4: Attach the LNB coax cable to the LNB as shown below. Feed the coax cable through the LNB arm as shown below.


Step 5: Attach the LNB to the arm using the remaining screw. See pictures below.




How you mount the dish will depend on your tripod. You want to be able to swivel the dish in azimuth and tip it in elevation.

The Detector:

The other important piece of the IBT is the detector. We use a simple Satellite Signal Meter that technicians use to point a dish at a suitable satellite. There are very cheap ones ($14.00) and expensive ones ($100.00). With the cheap and mid-priced meters, you will need to build a power supply.

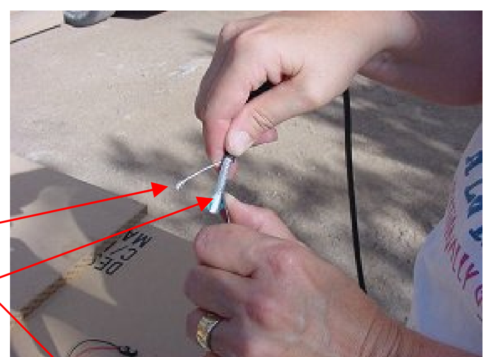
Procedure for assembling the power supply:

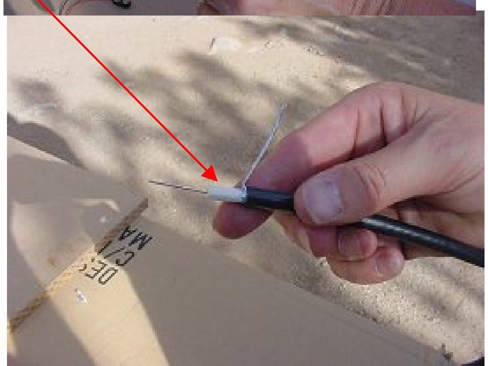
You will need 12 volts of DC power to operate a Channel Master Meter. Eight AA batteries will provide the power through a battery holder and 9-volt connector. You'll need about 18 volts for the cheapie signal meters. Two 9 volt batteries and a dual 9V battery snap will do the trick. Here's how to build a power supply (12 V) for the channel master tuning meter.

Cut off the end of a piece of coax cable.

2. Strip off about 2" of the black covering. Be careful not the cut through the silver wire braiding.

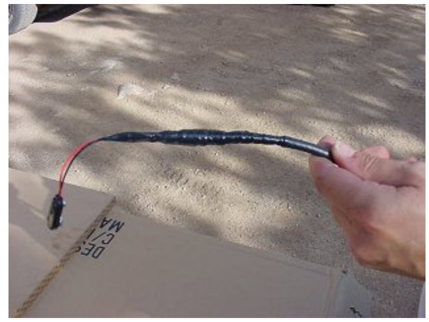
3. Comb and twist the silver wire braid shielding. Remove the foil shield, exposing the white insulation.





4. Be careful not to score the white insulation. Cut off about 1" of the white insulation, exposing the copper wire.
5. Use a small wire nut to connect the silver braid shielding of the coax cable to the black, or ground wire of the 9-volt battery connector. Use a small wire nut to connect the center wire of the coax cable to the red wire of the battery connector.

6. Using electrical tape, wrap from the insulation of the coax cable to the red and black leads of the 9-volt connector. Insert batteries into the battery clip. Attach the battery clip to the 9-volt connector.



7. Attach the coax from the LNB to the LNB terminal on the Channel Master.

8. Attach the coax from the battery pack to the SAT Rx terminal on the Channel Master.

You are done and ready to observe!!

Observing Activities and Ideas:

Activity 1: Turn your IBT to blank sky and adjust the gain to zero. Listen to the speaker or look at the meter. Now turn your IBT towards the ground and see/hear the difference. Remember that blank sky is about 3K while the ground is about 300K!

Activity 2: Now turn your IBT towards the Sun (see pics. below for help with aiming). Why isn't the Sun, with all its enormous energy (temperature of 6,000K!), pinning the meter? It turns out that the IBT dish has a beam width of 3^{o} while the Sun appears to be only 0.5^{o} in our sky. Thus the area of the dish occupied by the sun is small and the signal appears weaker than the ground at 300K.

Sun at "Full" meter deflection

Out of focus…

Getting closer…

Just about right.

Activity 3: Find the tree line and gaps between trees. The sensitivity of this IBT system is amazing and you can actually find the tops of trees and gaps between trees (if they are big enough). You could map the tree line using the angle of tilt of the antenna (altitude measured with an inexpensive angle finder available from hardware stores (Home Depot?)) and the azimuth found with a compass. See below:

Activity 4: Body temperature detection. As you've no doubt figured, nearly anything with a temperature can be detected with a radio telescope and people are no exception. Having a temperature of 300K (37^{o} C or 98.6^{o} F), your reading will be similar to the ground if you fill the beam. But you can have some fun with this… Try walking slowly past the telescope so the signal increases and then stabilizes and then decreases; or try using just your hand and make "music". The first musical use of this radio created music was the Theremin, played by waving your hands near antennas to vary pitch and amplitude – look it up on the web, it's fascinating!

Image from: en.wikipedia.org/wiki/Image: Leon_Theremin_Playing_Theremin.jpg

Activity 5: Satellite detection. Many geo-stationary satellites are in orbit above the Earth and many transmit radio signals. Much of this we would consider radio noise or radio pollution. Doing this activity may help you explain radio noise pollution better and it is always exciting for students to find a satellite they can't see. These satellite give off a very easy signal to detect and students may ask why the satellite looks like it has more energy than the sun. Remember though that the sun is a broadband (extremely!) transmitter whereas the satellite is a very narrow beam transmitter so all its energy it given off in a very narrow band.

Most of these satellites are in the Clarke belt (named after Arthur C. Clarke (author and engineer) who came up with the idea that you could create a geosynchronous orbit at a certain altitude above the Earth). For more info. check the web at: www.spacetoday.org/Questions/PolarSats.html or many other sites. Most of these satellites orbit above the equator so figure out where your celestial equator is by taking you latitude and subtracting it from 90^{o}. This is a rough altitude to look for satellites. Remember that the orbit will be near the ground in the east and west and forms an arc through the altitude you calculated in the south.

The Itty Bitty Telescope was designed by Society of Amateur Radio Astronomy Members Kerry Smith and Chuck Forster. It has been incorporated into the NRAO Navigators Program—an outreach program to promote radio astronomy. Become a Navigator!

If you have any questions, comments or concerns, we hope you will share them with us. It is our hope that you will use this system to help educate and expose people to the wonders of Radio Astronomy so that people can better understand what we do and why we do it. So please feel free to contact us.

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